RELATIONSHIPS BETWEEN SOLUBLE SUGAR CONCENTRATIONS IN ROOTS AND ECOSYSTEM STRESS FOR FIRST-YEAR SUGAR MAPLE SEEDLINGS

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Abstract. Accumulation of reducing sugars (i.e., glucose and fructose) in plant roots has been consistently correlated with forest dieback and decline and, therefore, has potential as a biological indicator of ecosystem stress. In this study, the relationships between acidic deposition and "natural" (temperature, mycorrhizae, and nutrition) factors with first-year sugar maple seedling root sugar concentrations and growth were assessed in two sugar maple dominated forests in Michigan. Seedlings at the southern site (Wellston) had greater root growth, phosphorus, total sugar, and sucrose concentrations in roots, but lower reducing sugar concentration in roots. In addition, percent root length colonized by vesicular-arbuscular mycorrhizal fungi was less than that found for seedlings growing at the northern site (Alberta). Throughfall deposition of nitrate, sulfate, and hydrogen ions was not significantly correlated with seedling total or reducing sugar concentration. Total sugar concentration in seedling roots was positively correlated with air and soil temperatures at the southern site, but not at the northern site. Seedling tissue phosphorus concentration was correlated with total sugars at both sites, with sucrose at the southern site, and reducing sugars at the northern site. Mycorrhizal colonization rates at the Alberta site were positively correlated with reducing sugar concentration in seedling roots and negatively correlated with sucrose concentration. The results suggest that differences in seedling root sugar concentrations in these two forests are related to seedling root growth and are most likely due to ecological variables, such as available soil phosphorus, temperature, and growing season length through some complex interaction with mycorrhizae rather than acidic deposition stress.

Key words: Acidic deposition, vesicular-arbuscular mycorrhizae, seedling nutrition, temperature

1. Introduction

Sugar maple (*Acer saccharum*, Marsh.) forests in the northeastern United States and eastern Canada have been reported to be in decline in recent decades (Chevonze and Linzon, 1988; Bauce and Allen, 1991). Most sugar maple declines have been attributed to natural stressors, such as defoliation, temperature, and drought (Millers *et al.*, 1989), nutritional stressors, particularly phosphorus (P) (Pare and Bernier, 1989), potassium (K) (Bernier and Brazeau, 1988a), or magnesium (Mg) (Bernier and Brazeau, 1988b) deficiencies, or anthropogenic factors (acidic deposition) (Bernier *et al.*, 1989). The most probable causes of the decline are interactions of natural, nutritional, and acidic deposition stresses (Bernier *et al.*, 1989).

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